CHAPTER 13

OPERATION MODES

13.1 Steady State Operation

In steady state operation the Fermilab STAR LHe refrigerator will supply refrigeration to the solenoid and the VLPC cryostats. Referring to Figure 7.2a, the refrigerator will operate to maintain the liquid level and pressure in the storage dewar at preset values, approximately 90% full and 1.8 atm, respectively. The valve legend for Figure 7.2a is shown in Figure 7.2b. Valve V10 will maintain a given mass flow through the solenoid and liquid level in the control dewar. Similarly V25 and V26 will maintain a given mass flow through the VLPC cryostats and liquid level in the VLPC cryostats. Approximately 1 g/s of He will flow out of the current leads at the control dewar to compressor suction.

13.2 Non Steady State Operation

13.2.1 Cooldown Mode

Magnet cooldown will use refrigeration from the LN2/He heat exchanger and gas engine (see Figure 7.2a). Some compressor flow, approximately 25 g/s, can be directed through the magnet cooling tubes and out the cooldown valve V11 back to suction. The magnet cold mass is 1460 kg which corresponds to a thermal energy of approximately 234 MJ from 300 K to 80 K and 14 MJ from 80 K to 4.4 K. Until the magnet reaches 80 K the cooldown rate is limited to 2 K/hr as discussed in Chapter 4. A cooldown time of less than one week should be achievable.

13.2.2 Magnet Charge and Discharge

During a seven minute energization of the magnet, eddy currents in the outer support cylinder cause an additional heat load of about 20 W or a total of about 8.4 kJ during the charging process. If necessary the mass flow through the magnet will be automatically increased. The refrigerator will increase its production to maintain the storage dewar liquid level. For normal discharge the refrigeration system will behave similarly but the additional heat load will be about 45 W.

13.2.3 Magnet Quench and Recovery

Upon detection of a quench valve V28 closes and the cooldown valve V11 opens. As the quench occurs the pressure in the magnet cooling tubes will rise and some liquid will be vaporized and some carried back to the suction of the refrigerator. Relief valves RV2 and RV3 open as necessary. Calculations given in Chapter 4 show that the maximum pressure expected in the cooling tubes is 520 psia (3.6 MPa).

Following the quench the magnet will be at a temperature of approximately 50 **K**. A cooldown sequence will be initiated which will restore the system to steady state in approximately 3/4 hour.

13.2.4 Loss of Compressor Flow

If the helium flow in the refrigerator circuit is lost due to a plug in the heat exchangers, power loss to the compressor, or the refrigeration capacity is lost due to a failed or inefficient gas engine, the storage dewar will act as a buffer supplying **LHe** to the magnet. Solenoid valves V14 and V15 open and V8 along with an electrical heater in the storage dewar maintains the delivery pressure at 1.8 atm. The flow through the magnet cooling tubes is not interrupted but the magnet will be ramped down.

13.2.5 Moving the Detector to and from the Collision Hall

When the detector is moved from the Assembly to the Collision Hall or vice-versa the helium and nitrogen systems will be disconnected. This will be accomplished by removing the He and N2 U-tubes (while cold) between the transfer line and the control dewar. The current lead return lines and vent lines will also be valved off and disconnected. The magnet coil will warm up toward 80 **K** during the move. The move is expected to take five days.

13.3 Liquid Nitrogen System Operation

The LN2 system is connected to the control dewar through a U-tube. The two nitrogen circuits in the magnet, the intercept circuit and the radiation shield circuit are independently refrigerated by valves V23/V24 on the LN2 supply, which are controlled by temperature sensors T4/T5 on the return or discharge. In either operating position, LN2 is supplied from the bulk storage tank via the transfer line and U-tubes.